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512 Rec'd PCT/PTO 19 JUN 2000

ATTORNEY'S DOCKET NUMBER CE30343P

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

jc841 U.S. PTO 06/19/00

U.S. APPLICATION NO. 09/581895

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP98/08120	07 December 1998	17 December 1997

TITLE OF INVENTION:

A METHOD FOR PREDICTING INTERFERENCE

APPLICANT(S) FOR DO/EO/US
MOHEBBI

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [x] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the application time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [x] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   - b. [x] has been transmitted by the International Bureau
   - c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] A translation of the International Application into English (35 U.S.C. 371 (c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   - a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   - b. [ ] has been transmitted by the International Bureau.
   - c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   - d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern other document(s) or information included:

11. [ ] An information Disclosure Statement under 37 CFR 1 97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [ ] Other items or information:

430 Rec'd PCT/PTO 19 JUN 2000

U.S. Application No (if known, see 37 CFR1 5)	International Application No	Attorney Docket Number
09/581895	PCT/EP98/08120	CE30343P

17. [x] The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5):

	CALCULATIONS	PTO USE ONLY
Search report has been prepared by the EPO or JPO. $840.00		
International preliminary examination fee paid to USPTO (37 CFR 1 482) $670.00		
No International preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445 (a)(2)).....................$690.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO..........................$970.00		
Intentional preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $96 00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840.00	
Surcharge of $130.00 for furnishing the oath and declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)). +	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	10 - 20 =		X $18.00	$	
Independent Claims	2 - 3 =		X $78.00	$	
Multiple dependent claim(s) (if applicable)			+$260.00	$	

TOTAL OF ABOVE CALCULATIONS =	$ 840.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).	$	
SUBTOTAL:	$ 840.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +	$	
TOTAL NATIONAL FEE =	$ 840.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +	$	
TOTAL FEES ENCLOSED =	$ 840.00	
	Amount to be refunded	$
	Charged	$ 840.00

a. ☐ A check in the amount of $__________ to cover the above fees is enclosed.

b. [x] Please charge my Deposit Account No. 50-0280 in the amount of $840.00 to cover the above fees. A duplicate copy of this sheet is enclosed

c. [x] The Commissioner is hereby authorized to charge any additional fees which may be required now or in the future under 37 CFR 1.16 or 37 CFR 1.17, including any present or future time extension fees which may be required, or credit any overpayment to Deposit Account No. 50-0280. Two duplicate copy of this sheet is enclosed.

Note: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:

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414 Rec'd PCT/PTO 10 OCT 2000

PCT# Buet 10/18/00

OIPE OCT 1 0 2000 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

DOCKET NUMBER: **CE030343P**
INT'L APPL. NO. **PCT/EP98/08120**
PRIORITY DATE: **12/17/97**
I.A. FILING DATE: **12/07/98**

APPLICANTS: **Mohebbi**
SERIAL NO. **09/581,895**
FILING DATE: **06/19/00**
ENTITLED: **Method for Predicting Interference**

Certificate of Mailing
I hereby certify that this correspondence is being deposited with the United States Postal Service via 1st Class Mail and addressed to: Box: Missing Parts, Assistant Commissioner of Patents, Washington, D.C. 20231 on 10-5-00
Date
T. Dena
T. Dena

TRANSMITTAL

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Enclosed please find with this transmittal letter the following documents for filing in the above-styled case:

1. Petition for a Two Month Extension of Time Under 37 C.F.R. §1.136(a);
2. Copy of Notification of Missing Requirement;
3. Response to Notification of Missing Requirement;
4. Executed Declaration and Power of Attorney by inventor; and
5. Return receipt postcard.

10/16/2000 MBIZUNES 00000042 500280 09581895
02 FC:154 130.00 CH

Respectfully submitted,
Mohebbi

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09/581895
430 Rec'd PCT/PTO 19 JUN 2000

A METHOD FOR PREDICTING INTERFERENCE

Field of the Invention

The present invention relates to a method for predicting interference in a communications network, for example, a cellular telecommunications network, such as a Global System for Mobile Communications (GSM) network.

Background of the Invention

When a cellular telephone network is planned, it is known in the art to employ a three cell reuse pattern. Such a pattern comprises a plurality of sites, each of the plurality of sites being divided into three cells and allocated a predetermined number of frequencies for the purpose of frequency hopping. A first cell is allocated a first set of frequencies, a second cell is allocated a second set of frequencies and a third cell is allocated a third set of frequencies. The frequencies and the allocation thereof is identical for each site.

However, such a plan does not account for sources of interference, for example, geographic obstacles and topography of the terrain covered by the network. This often leads to some cells having lower capacity than the majority of cells. The lower capacity cells set a limit on the network capacity as a whole.

It is therefore an object of the present invention to obviate or mitigate the problems associates with frequency planning in a cellular network.

Summary of the Invention

According to a first aspect of the present invention, there is provided, a method for predicting interference experienced by a first cell from a second cell, both cells having at least one frequency hopping parameter, the method comprising the steps of: determining an estimated interference level corresponding to interference experienced by the first cell due to the second cell; calculating the probability of the first cell hopping to substantially the same frequency as the second cell; weighting the estimated interference level with the calculated probability, and modifying the at least one frequency

hopping parameter in order to modify the weighted estimated interference level.

According to a second aspect of the present invention, there is provided a method of optimizing calculations corresponding to a first cell in a frequency hopping network, comprising the steps of: fitting a probability model to the probability of cells in the network hopping to substantially the same frequency; determining the cells in the network which have a probability above to a predetermined threshold of hopping to substantially the said frequency, and executing the calculations for the first cell based upon the sources of interference to the first cell which are in the determined cells.

Other, preferred, features and advantages will become apparent from the accompanying dependent claims and the following description.

It is thus possible to provide a method and apparatus for optimizing a communications network which has the maximum capacity achievable by controlling the level and probability of interference associated with frequency hopping.

Brief Description of the Drawings

At least one embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a schematic diagram of three cells in a cellular network for use with the present invention;

FIG. 2 is a block diagram of frequencies assigned to the three cells of FIG. 1;

FIG. 3 is a flow diagram constituting an embodiment of the present invention;

FIG. 4 is a flow diagram of a step shown in FIG. 3;

FIG. 5 is a flow diagram of an enhancement of FIG. 3, and

FIG. 6 is a probability distribution for use with the enhancement of FIG. 5.

Description of a Preferred Embodiment

A cellular telecommunication network 100 (FIG.1), for example, a GSM network, comprises a first cell 102, a second cell 104 and a third cell 106 having a respective first base station 108, second base station 110 and third base station 112 located therein. The first, second and third cells 102, 104, 106 are, for simplicity of description, omicells, but other cell configurations known in the art can be used. The first, second and third base stations 106, 108, 110 can be M-CELL base stations manufactured by Motorola Limited.

Referring to FIG. 2, a first set of frequencies 200 is allocated to the first cell 102. The first base station 108 operates in a frequency hoping mode and can select any frequency from the first set of frequencies 200 for transmission of a time slot.

A second set of frequencies 202 is allocated to the second cell 104. The second base station 110 operates in a frequency hoping mode and can select any frequency from the second set of frequencies 202 for transmission of a time slot.

Similarly, a third set of frequencies 204 is allocated to the third cell 106. The third base station 112 operates in a frequency hopping mode and can select any frequency from the third set of frequencies 204 for transmission of a time slot.

Operation of the invention will now be described with reference to FIG. 3.

A cell is selected for optimization (step 300), for example, the first cell 102, by setting a variable, test_cell, equal to 1. The system determines (step 302) whether a total number of the cells for optimization, c, have had their corresponding interference level calculated. In the above simplified example, c is equal to 3.

An interference level and associated statistical data for the first cell, I_{cell1}, is calculated (step 304) as follows.

Referring to FIG. 4, an interference matrix $I_{(c,c)}$ is generated (step 402) containing interference levels corresponding to the predicted interference experienced by each cell in the network as a result of other cells in the network. The interference levels can be measured, or estimated using the Netplan software package supplied by Motorola, Inc. The interference matrix $I_{(c,c)}$ has a structure as shown in Table 1 below.

	Cell 1	Cell 2	...	...	...	Cell c
Cell 1	$I_{(1,1)}$	$I_{(1,2)}$	...	...	...	$I_{(1,c)}$
Cell 2	$I_{(2,1)}$	$I_{(2,2)}$	...	...	...	$I_{(2,c)}$
...	...	...	...	...	...	...
...	...	...	...	...	...	...
Cell c	$I_{(c,1)}$	$I_{(c,2)}$	...	...	...	$I_{(c,c)}$

Table 1

When the Netplan software is used, a range of interference levels are generated corresponding to the interference levels at different locations in, for example, the first cell 102. In order to calculate a corresponding single value for each element of the interference matrix $I_{(c,c)}$, it is necessary to process the range of interference levels generated relating to, for example, the first cell 102 in order to obtain the single value corresponding to a nominal interference level. Such processing techniques can include the statistical mode, medium or mean, or the maximum or minimum interference level in, for example, the first cell 102. This processing technique is repeated with appropriate changes so as to calculate each entry in the interference matrix $I_{(c,c)}$. It should be appreciated that other processing techniques known in the art can be used to obtain each single value.

Once the element of the interference matrix $I_{(c,c)}$ has been calculated (step 402), a combination table containing data relating to the possible different

combinations of cells interfering with the first cell 102 is generated (step 404) as shown in Table 2 below.

Cell 2	Cell 3
0	0
0	1
1	0
1	1

Table 2

The above table conforms to an incremental binary sequence. Table 2 forms part of a larger table (Table 3) shown below (the last four rows of the columns relating to Cell 2 and Cell 3). However, when optimizing the first cell 102, those cells which can interfere with the first cell 102 are only of interest and so the first four rows of the table are ignored.

Cell 1	Cell 2	Cell 3
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Table 3

The 1's in the combination table (Table 2) represent the possibility of a cell interfering with the first cell 102. The 0's in the matrix represent the possibility of a cell not interfering with the first cell 102.

Given the frequency allocation of FIG. 2, it is possible to calculate a first probability of the first cell 102 hopping to a substantially identical frequency as the second cell 104.

The first probability can be expressed as:

$P\{h_2\}$ = P{Both cell 1 and cell 2 hop to the same frequency} = P{cells 1 and 2 hop to f_1} OR P{cells 1 and 2 hop to f_2} OR P{cell 1 and 2 hop to f_3}

$$= \frac{1}{4}.\frac{1}{3} + \frac{1}{4}.\frac{1}{3} + \frac{1}{4}.\frac{1}{3} = \frac{1}{4}$$

Similarly, it is also possible to calculate a second probability of the first cell 102 hopping to a substantially identical frequency as the third cell 106.

The second probability can be expressed as:

$P\{h_3\}$ = P{Both cell 1 and cell 3 hop to the same frequency} = P{cells 1 and 3 hop to f_2} OR P{cells 1 and 3 hop to f_3} OR P{cell 1 and 3 hop to f_4}

$$= \frac{1}{4}.\frac{1}{3} + \frac{1}{4}.\frac{1}{3} + \frac{1}{4}.\frac{1}{3} = \frac{1}{4}$$

It should be appreciated that the values of the first and second probabilities will depend upon the number of frequencies in common between the first, second and third sets 200, 202, 204 of frequencies and the number of frequencies used for hopping. The first and second probabilities can be calculated according to any method known in the art.

Each row of the combination table (Table 2) is then analysed to identify cells which could possibly interfere with the first cell 102 and an expected interference value is calculated (step 406) for each row as follows.

An entry in the combination table (Table 2) indicating a possible interference with the first cell 102, i.e. having a '1' in the appropriate location, is identified. Thus, no 1's are present in the first row and so this row contemplates the situation where neither cell 2 nor cell 3 interfere with cell 1. Consequently, an expected interference level of 0 is recorded.

The second row signifies the possible interference between the first cell 102 and the third cell 106 only. The interference level $I_{(1,3)}$ in the interference matrix $I_{(c,c)}$ corresponding to the interference experienced by the first cell 102 due to the third cell 106 is extracted from the interference matrix $I_{c,c}$. If another entry were to exist in the second row of the combination table (Table

2), an additional entry in the interference matrix $I_{(c,c)}$ is identified and extracted.

Once all of the possible interfering cells have been identified for the second row in the combination table (Table 2), the interference levels extracted are multiplied, or weighted, by corresponding probabilities calculated above relating to the probability of two cells hopping to a substantially identical frequency. For example, for the second row of the combination table (Table 2), the calculation will be as follows:

$$p(h_3) \times I_{(1,3)}$$

The same procedure is applied to the third and fourth rows of the combination table (Table 2). Thus, for the third row, the weighted interference level is calculated as follows:

$$p(h_2) \times I_{(1,2)}, \text{ and}$$

for the fourth row, the weighted interface level is calculated as follows:

$$p(h_2) \times I_{(1,2)} + p(h_3) \times I_{(1,3)}$$

The weighted interference levels corresponding to each row of the combination table (Table 2) are then summed in order to generate an interference level corresponding to the possible combination of cells which can interfere with Cell 1.

The next cell to be optimized is then selected by incrementing (step 306) the variable, test_cell. It is then determined whether all the cells have been analysed (step 302), i.e. whether c has been reached.

The above process is then repeated for each cell to be optimized until weighted interference levels have been generated for each of the cells to be optimized.

A probability density function (PDF) corresponding to the weighted interference levels of the cells to be optimized is generated (step 408), for

example, using a "bin count" method known in the field of statistics, and a cumulative density function (CDF) is then generated (step 410) using the PDF.

An analytical or visual means for representing the weighted interference levels of the cells is thereby provided.

The poorest performing cells are then identified using either the weighted interference levels or the CDF, and can be optimized by modifying the number and distribution of frequencies (step 314) in order to modify the weighted interference levels so as to obtain an optimum interference level throughout the network.

It should be appreciated that the interference levels are not the only criteria which can be used to optimize the network and other criteria, for example, probability levels can be used.

The above example has been described with reference to three cells for simplicity and clarity. However, it should be appreciated that a greater number of cells can be employed in the network 100.

As a further enhancement (FIG. 5) to the above technique, the interference characteristics of the network 100 can be modelled using a probability distribution, for example, a binomial distribution (step 600).

The binomial distribution can then be used to reduce the number of computations required by determining the number of cells which are likely to contribute significantly to interference experienced by a given cell.

For example, as shown in FIG. 6, the network 100 may comprise 19 cells using 6 identical frequencies for frequency hopping. The binomial distribution for such an arrangement shows that the probability of 10 cells or more using the same frequency at the same time is very low. Therefore, in order to reduce the computational burden, the first 10 strongest interfering cells (which can be determined from the interference matrix $I_{(c,c)}$) can be used (step 602) for network optimization in accordance with the method described above, instead of using all the cells in the network. An additional modification to the method being that the interference matrix is generated (step 604 and step 606) based upon the selected number of interfering cells.

Since a subset of all possible permutations of cells is only considered, a correction factor can be applied, for example, a simple ratio between the number of permutations ignored and the number of total possible permutations. However, if the contribution to the interference level from the ignored cells is minimal, the correction factor may not be required.

Claims

What is claimed:

1. A method for predicting interference experienced by a first cell from a second cell, both first and second cells having at least one frequency hopping parameter, the method comprising the steps of:

determining an estimated interference level corresponding to interference experienced by the first cell due to the second cell;

calculating the probability of the first cell hopping to substantially the same frequency as the second cell;

weighting the estimated interference level with the calculated probability; and

modifying the at least one frequency hopping parameter in order to modify the weighted estimated interference level.

2. The method as claimed in Claim 1, wherein the at least one frequency hopping parameter is the number of frequencies used by the first cell.

3. The method as claimed in claim 1, wherein the at least one frequency hopping parameter is the choice of frequencies used for frequency hopping by the first cell.

4. The method as claimed in claim 1, further comprising providing further cells having further corresponding frequency hopping parameters, and:

determining further estimated interference levels corresponding to interference experienced by the first cell due to further cells;

calculating the further probabilities of the first cell hopping to substantially the same frequency as each of the further cells;

weighting the further estimated interference levels with the corresponding calculated further probabilities; and

modifying the at least one frequency hopping parameter in order to optimize the weighted estimated interference level and the further weighted estimated interference levels.

5. The method as claimed in claim 4, further comprising forming a matrix including the estimated interference level and the further weighted estimated interference levels.

6. The method as claimed in claim 5, further comprising forming a probability density function based on the weighted estimated interference level and the further weighted estimated interference levels.

7. The method as claimed in claim 6, further comprising forming a cumulative density function based on the probability density function.

8. A method of optimizing calculations corresponding to a first cell in a frequency hopping network, comprising the steps of:

fitting a probability model to the probability of cells in the network hopping to substantially the same frequency;

determining the cells in the network which have a probability above a predetermined threshold of hopping to substantially the said frequency; and

executing the calculations for the first cell based upon the sources of interference to the first cell which are in the determined cells.

9. The method as claimed in claim 8, wherein the determined cells comprise the strongest sources of interference in the network.

10. The method as claimed in any one of claim 8, wherein the probability model is a binomial probability model.

A METHOD FOR PREDICTING INTERFERENCE

Abstract of the Invention

A method for predicting interference experienced by a first cell (102) from a second cell (104), where both cells (102, 104) have at least one frequency hopping parameter, comprises the steps of determining (step 402) an estimated interference level corresponding to interference experienced by the first cell (102) due to the second cell (104); calculating the probability of the first cell hopping to substantially the same frequency as the second cell; weighting (step 406) the estimated interference level with the calculated probability, and modifying (step 314) the at least one frequency hopping parameter in order modify the weighted estimated interference level.

(FIG. 3)

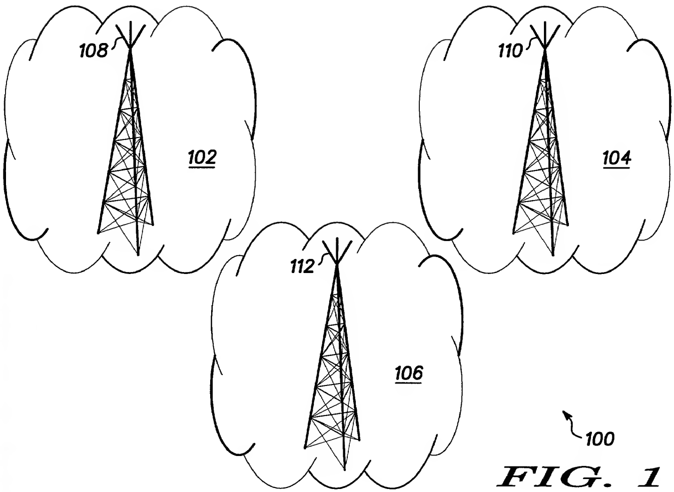

108
110
102
104
112
106
100

FIG. 1

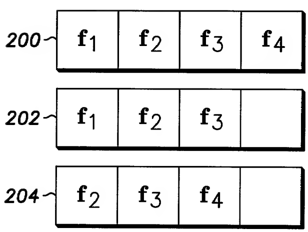
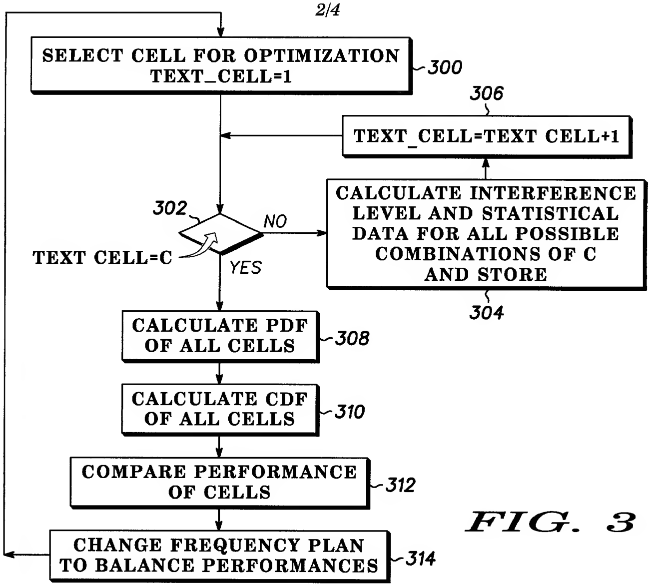
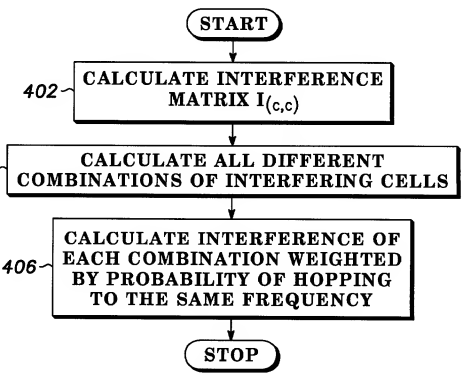

200
f1
f2
f3
f4
202
f1
f2
f3
204
f2
f3
f4

FIG. 2



SELECT CELL FOR OPTIMIZATION
TEXT_CELL=1
300
306
TEXT_CELL=TEXT CELL+1
CALCULATE INTERFERENCE LEVEL AND STATISTICAL DATA FOR ALL POSSIBLE COMBINATIONS OF C AND STORE
304
302
NO
TEXT CELL=C
YES
CALCULATE PDF OF ALL CELLS
308
CALCULATE CDF OF ALL CELLS
310
COMPARE PERFORMANCE OF CELLS
312
CHANGE FREQUENCY PLAN TO BALANCE PERFORMANCES
314

FIG. 3



START
402
CALCULATE INTERFERENCE MATRIX I(c,c)
404
CALCULATE ALL DIFFERENT COMBINATIONS OF INTERFERING CELLS
406
CALCULATE INTERFERENCE OF EACH COMBINATION WEIGHTED BY PROBABILITY OF HOPPING TO THE SAME FREQUENCY
STOP

FIG. 4

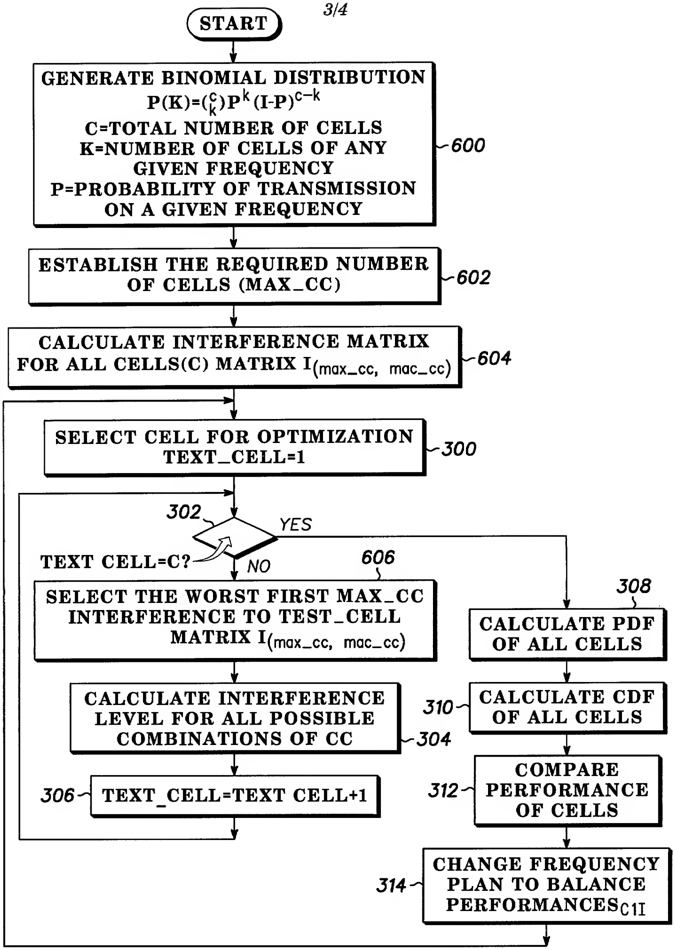

START
GENERATE BINOMIAL DISTRIBUTION
$P(K)=\binom{c}{k}P^k(I-P)^{c-k}$
C=TOTAL NUMBER OF CELLS
K=NUMBER OF CELLS OF ANY GIVEN FREQUENCY
P=PROBABILITY OF TRANSMISSION ON A GIVEN FREQUENCY
600
ESTABLISH THE REQUIRED NUMBER OF CELLS (MAX_CC)
602
CALCULATE INTERFERENCE MATRIX FOR ALL CELLS(C) MATRIX $I_{(max\_cc,\ mac\_cc)}$
604
SELECT CELL FOR OPTIMIZATION TEXT_CELL=1
300
302
TEXT CELL=C?
YES
NO
606
SELECT THE WORST FIRST MAX_CC INTERFERENCE TO TEST_CELL MATRIX $I_{(max\_cc,\ mac\_cc)}$
CALCULATE INTERFERENCE LEVEL FOR ALL POSSIBLE COMBINATIONS OF CC
304
306
TEXT_CELL=TEXT CELL+1
308
CALCULATE PDF OF ALL CELLS
310
CALCULATE CDF OF ALL CELLS
312
COMPARE PERFORMANCE OF CELLS
314
CHANGE FREQUENCY PLAN TO BALANCE PERFORMANCES$_{C1I}$

FIG. 5

09/581895

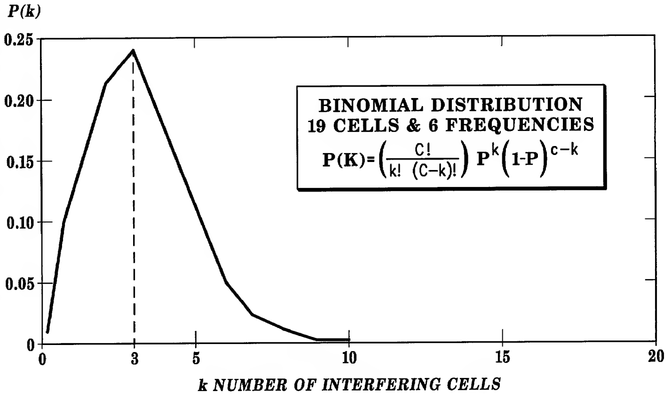


FIG. 6

OIPE
OCT 1 0 2000
PATENT & TRADEMARK OFFICE

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

Attorney Docket **CE30343P**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **A METHOD FOR PREDICTING INTERFERENCE** the specification of which is attached hereto unless the following box is checked:

☑ was filed on **06/19/00** as Application No. **09/581,895**
and was amended on ______________.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

(Number)	(County)	(Day/Month/Year Filed)	Priority Claimed
9726644.9	United Kingdom	December 17, 1997	☒Yes ☐No
PCT/EP98/08120	PCT	December 7, 1998	☒Yes ☐No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

______________________ ______________________
(Application Number) (Filing Date)

______________________ ______________________
(Application Number) (Filing Date)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §12, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF FIRST INVENTOR	INVENTOR'S SIGNATURE:	DATE:
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